Treating the Harmful Cyanobacteria Bloom (HCB) at Ross Island lagoon

Desiree Tullos, PhD, PE (OR)

HCBs are an environmental justice issue

HCB impacts to fish

Studies have demonstrated reduced survival
of salmon during blooms.

Fraser river sockeye salmon marine survival
decline and harmful blooms of *Heterosigma
akashiwo*

J.E. Jack Rensel [a], Nicola Haigh [b], Tim J. Tynan [c]

Marine survival of juvenile sockeye salmon: 2.7% in years
coinciding with major blooms versus 10.9% in no or
minor bloom index years.

Mechanisms:

- Low dissolved oxygen

- High pH

- Acute toxicity

- Preferred food replaced by cyanos

HCB impacts to fish

Source: Ethan Ableman 2010

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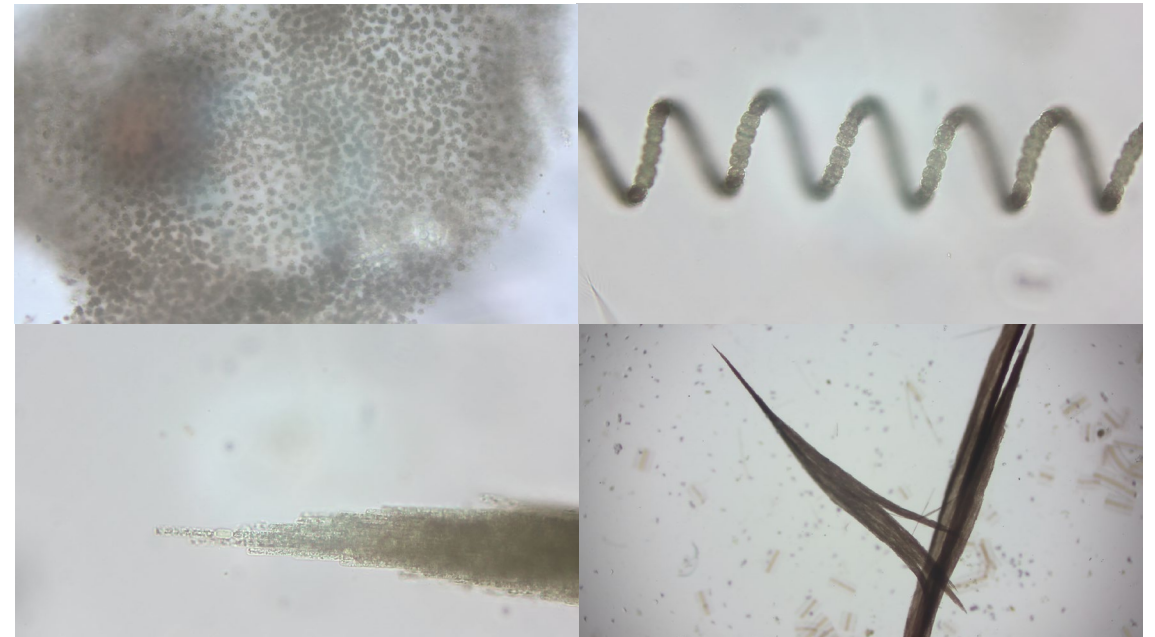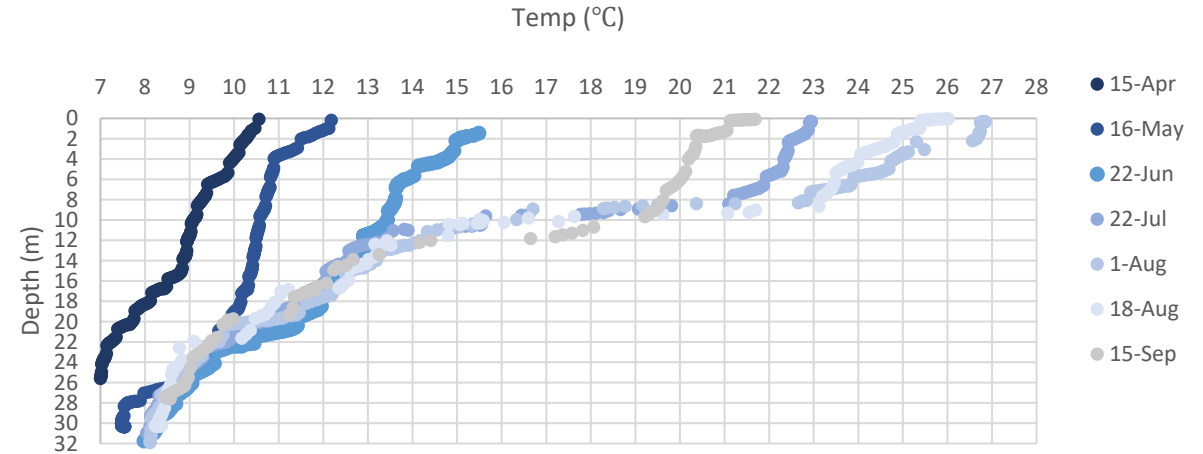minor bloom index years.

Mechanisms:

• Low dissolved oxygen

• High pH

• Acute toxicity

• Preferred food replaced by cyanos

So how do we solve this problem??

Step 1: Learn about lagoon

The lagoon was a data desert.

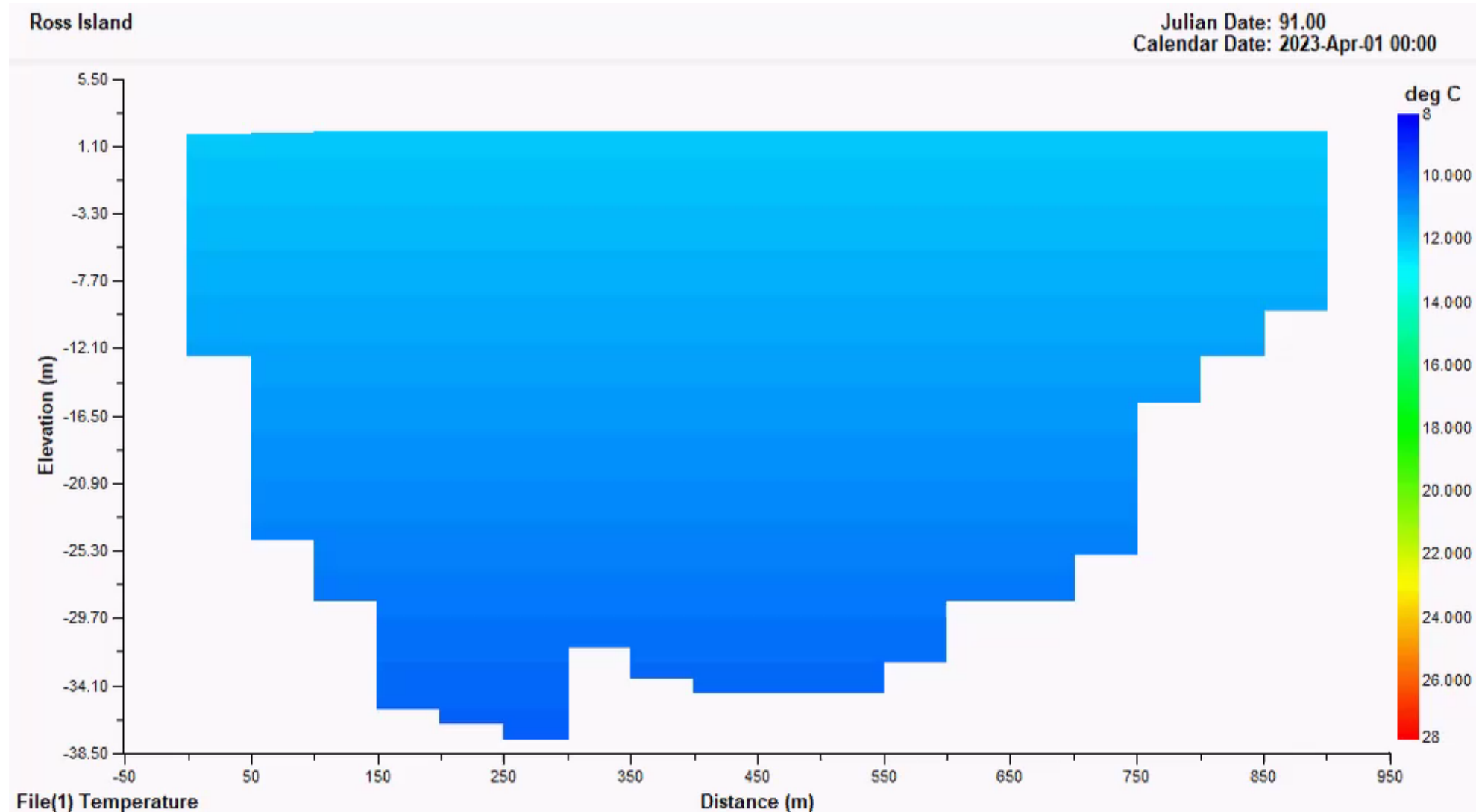Develop baseline understanding of hydrodynamics and ecosystem.
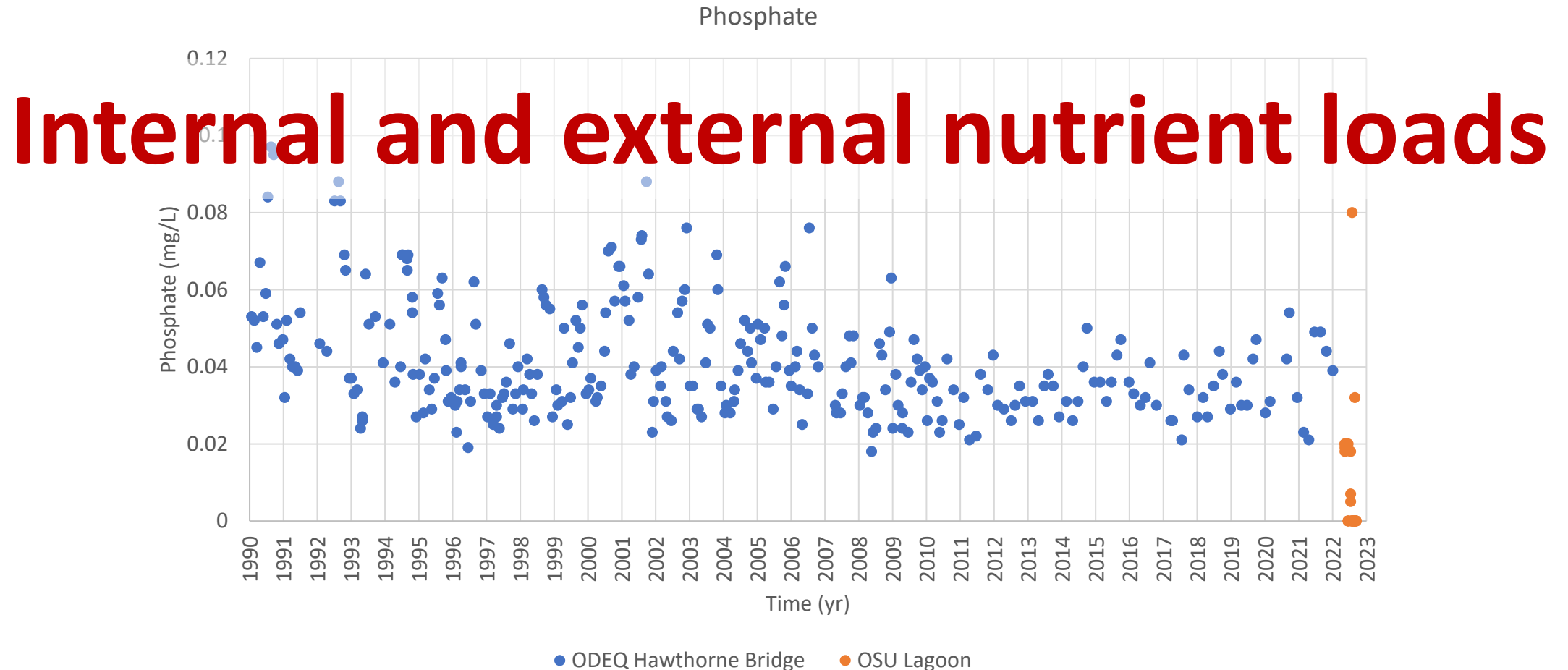
Rehabilitation of Ross Island Lagoon

Overcoming a Harmful Cyanobacterial Bloom (HCB) in the Heart of Portland, Oregon

Desirée Tullos & Rowan Fay & Willie Levenson

Stratification – hot top, cold bottom

Adequate nutrients in the river to feed bloom

Internal and external nutrient loads

Phosphate

Tidally- (and wind) driven hydrodynamics

So how do we solve this problem??

Step 2: Evaluate MANY options

Stagnant water

1. Destratification
2. Flushing channel

Hot water (>16C)

3. Mixing up cold water

Excess nutrients

4. Phosphorus immobilization

nutrient source

Internal nutrient source

External nutrient source

Large treatment area or small budget

Small treatment area or large budget

Internal — Large treatment area or small budget — Connected to sensitive ecosystem
P immobilization***
Algal scrubbers
Flow manipulation

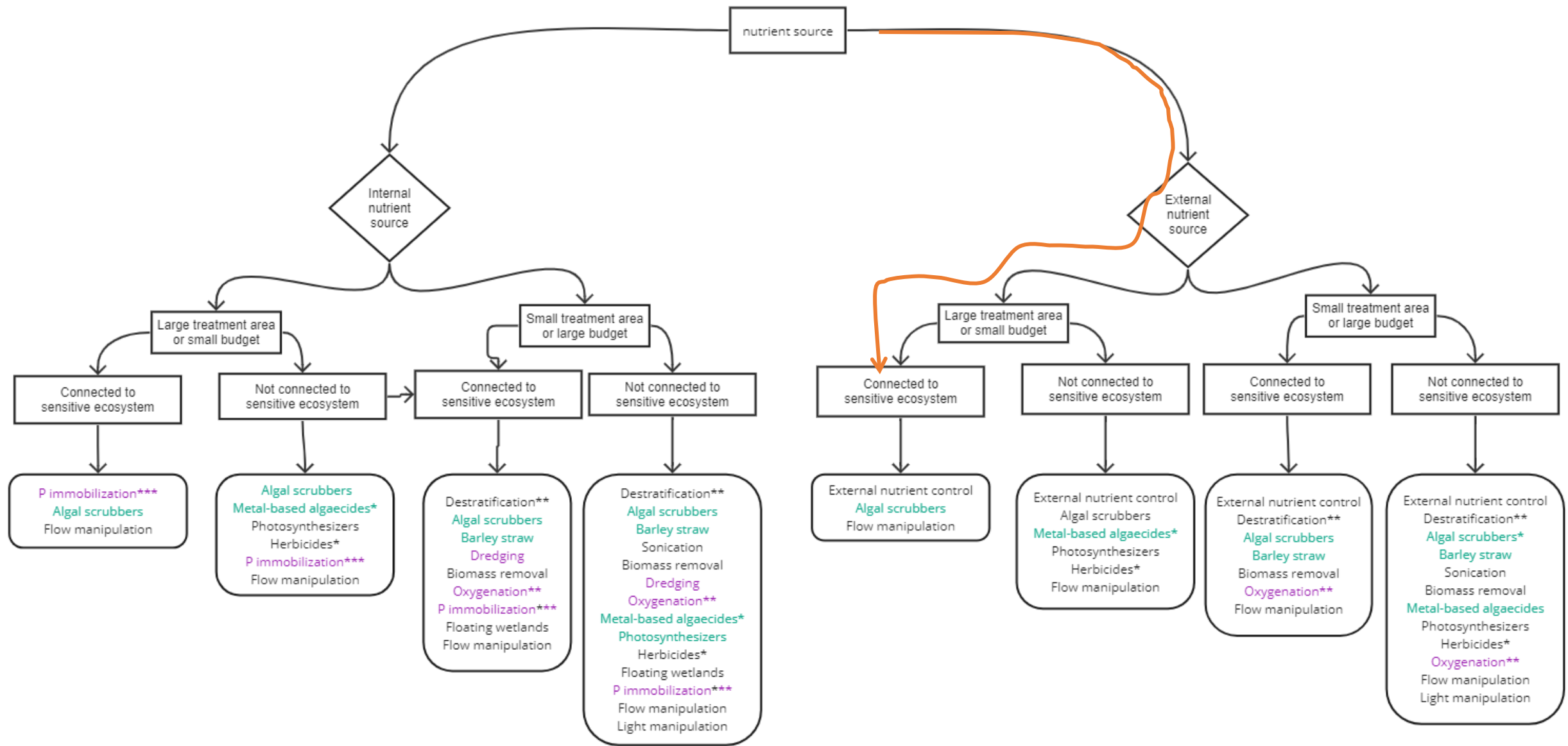**Internal — Large treatment area or small budget — Not connected to sensitive ecosystem**
Algal scrubbers
Metal-based algaecides*
Photosynthesizers
Herbicides*
P immobilization***
Flow manipulation

Internal — Small treatment area or large budget — Connected to sensitive ecosystem
Destratification**
Algal scrubbers
Barley straw
Dredging
Biomass removal
Oxygenation**
P immobilization***
Floating wetlands
Flow manipulation

Internal — Small treatment area or large budget — Not connected to sensitive ecosystem
Destratification**
Algal scrubbers
Barley straw
Sonication
Biomass removal
Dredging
Oxygenation**
Metal-based algaecides*
Photosynthesizers
Herbicides*
Floating wetlands
P immobilization***
Flow manipulation
Light manipulation

External — Large treatment area or small budget — Connected to sensitive ecosystem
External nutrient control
Algal scrubbers
Flow manipulation

External — Large treatment area or small budget — Not connected to sensitive ecosystem
External nutrient control
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Flow manipulation
Light manipulation

Phosphorus treatment only
* toxicity concern
pH concern
**only in stratified/unmixed water bodies

Tullos et al. (in review)

Most promising alternative: Restore flushing flows to lagoon

- Most effective
- Non-structural
- Least maintenance
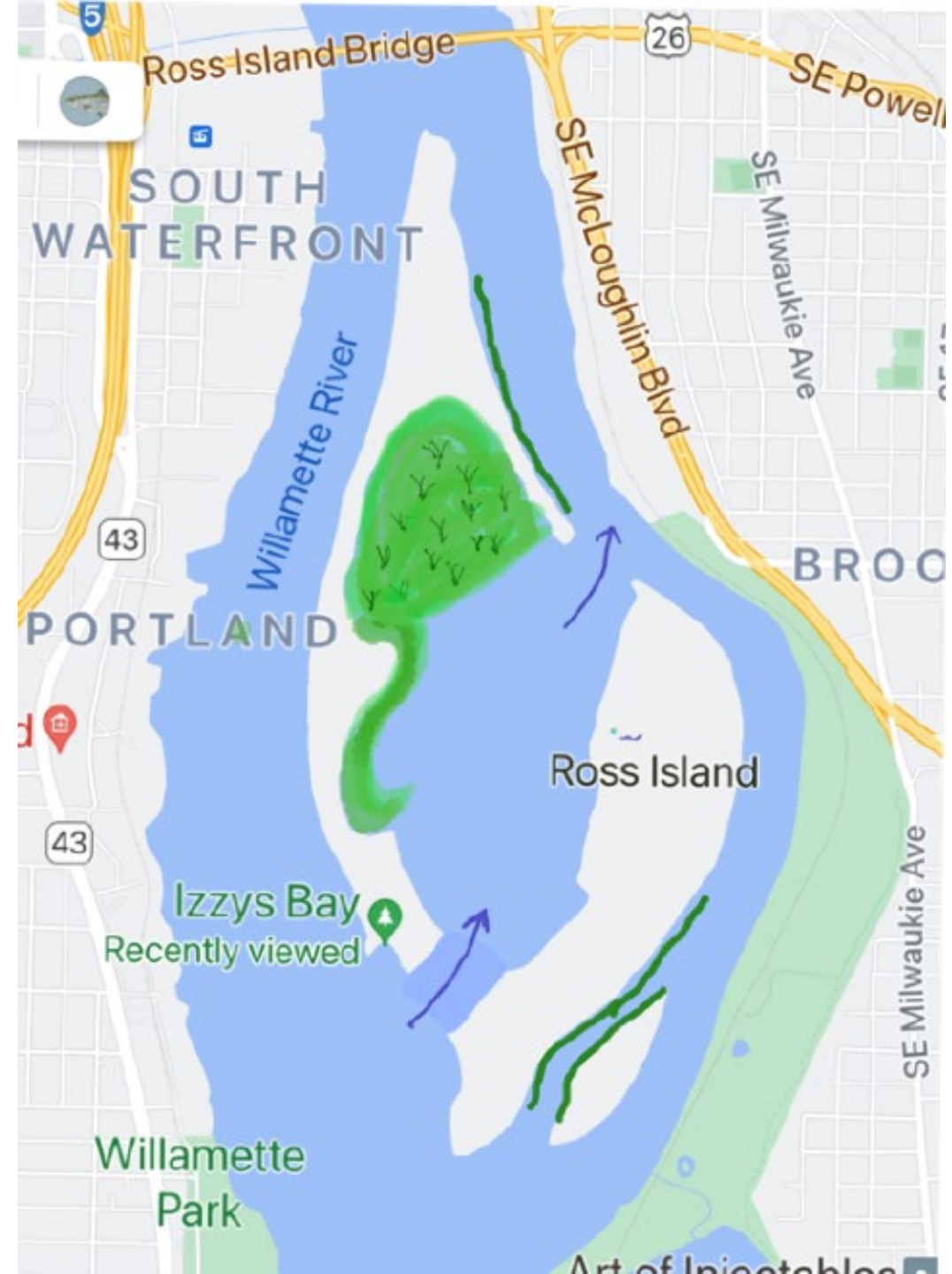- Least carbon/energy for operations

Figure: Paul Fishman

# Flushing channel design in progress

Source: ODFW

- **Stable channel**: Engineered material designed to be stable up to a design flow (e.g. 1% exceedance)

- **Fish passage:** Meets fish passage criteria at high and low flows

- **Entrance/exit:** Careful design needed at transitions into/out of channel

- **Unique design elements:** Difference will be in channel slope and bidirectional flow

Cyanobacteria

- No Channel (top)

- ~2m Channel (bottom left)

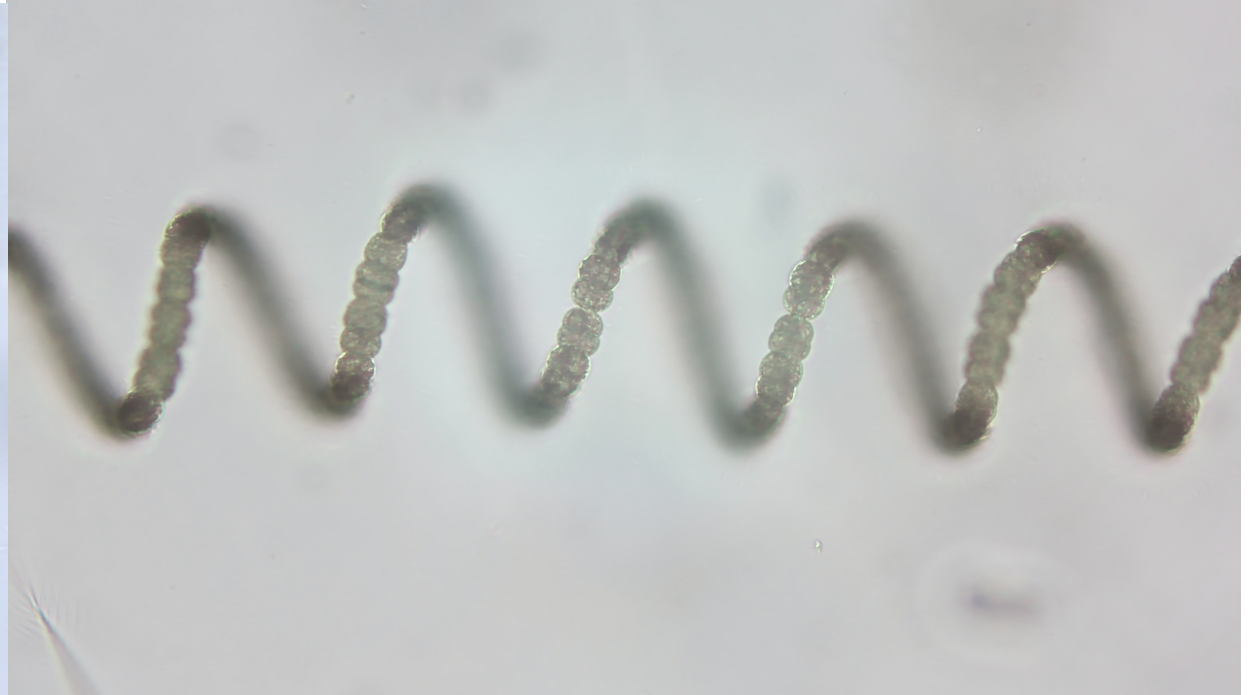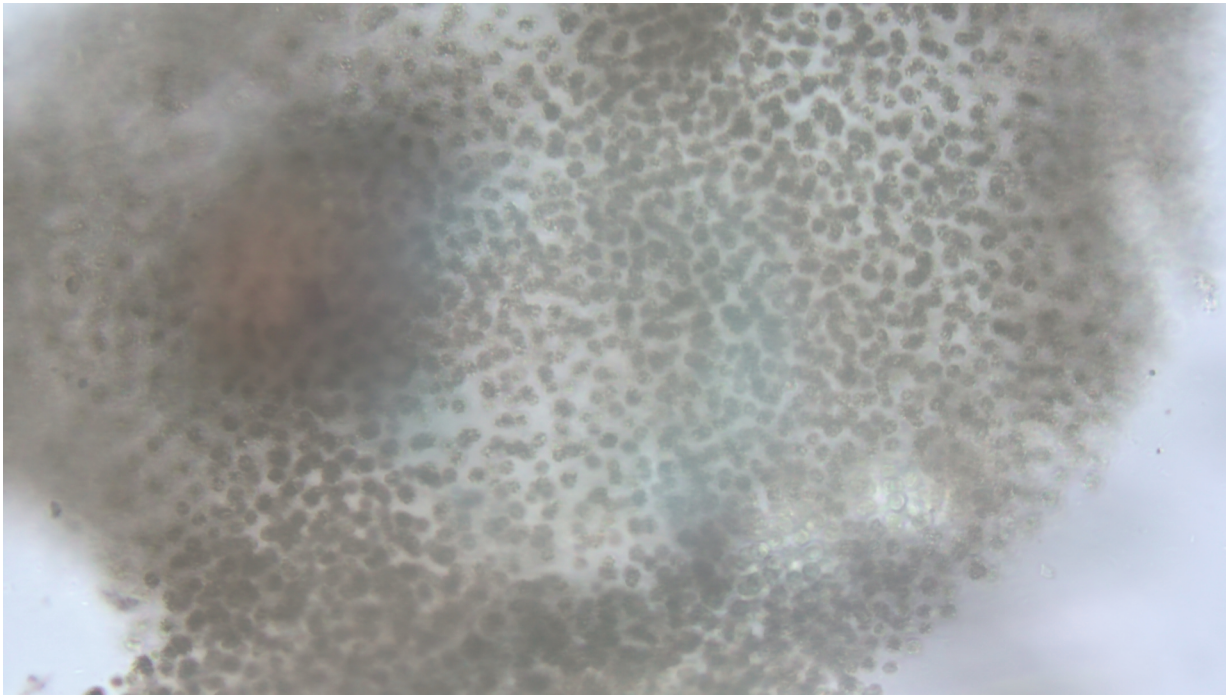- ~10 m Channel (bottom right)
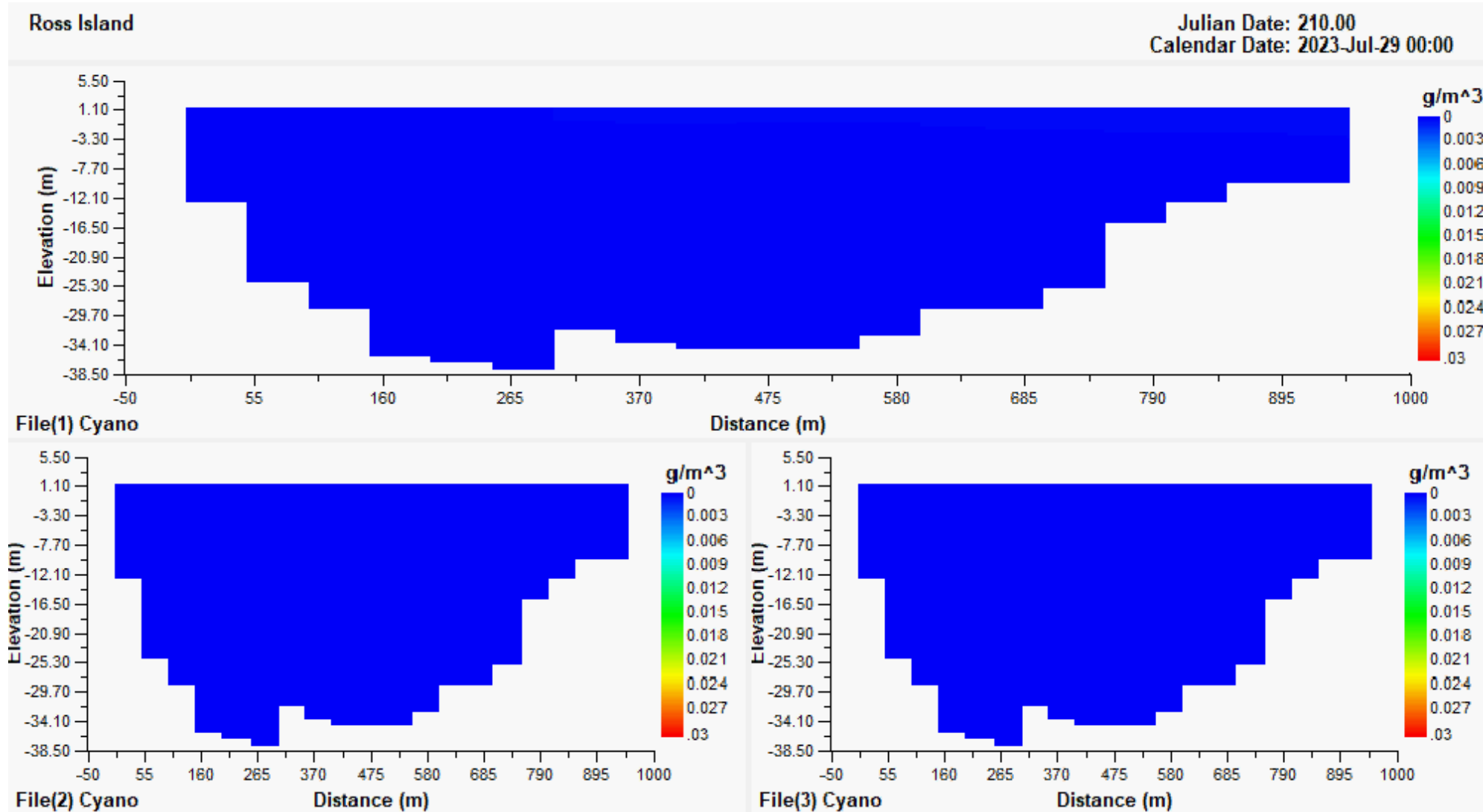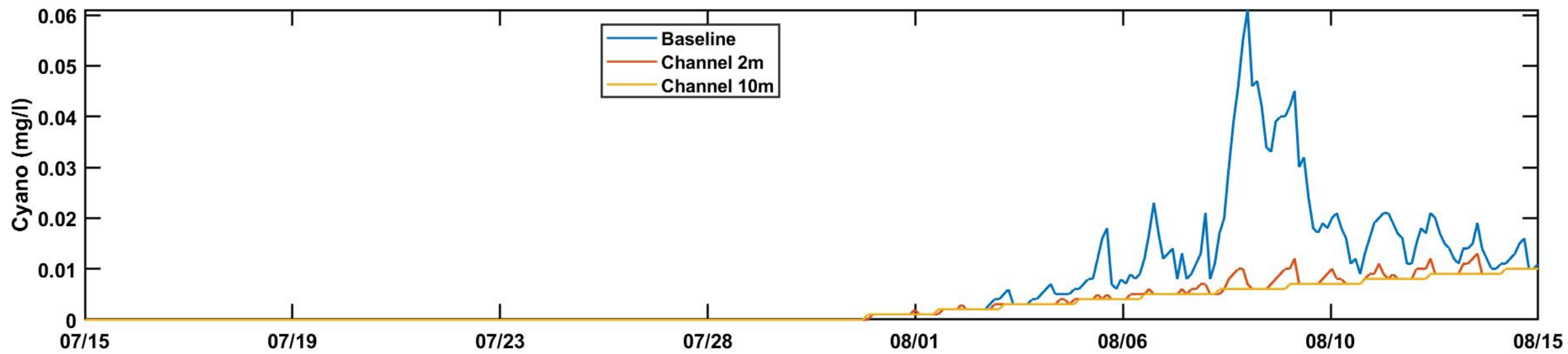
Summary

- RIL is not a lake and not a river.
  - Deep stratified middle (like a lake)
  - Shallow, mixed margins (like a river)
- Tradeoffs among the different strategies – cost, permitting difficulty, energy demands/carbon footprint, O&M, fish access
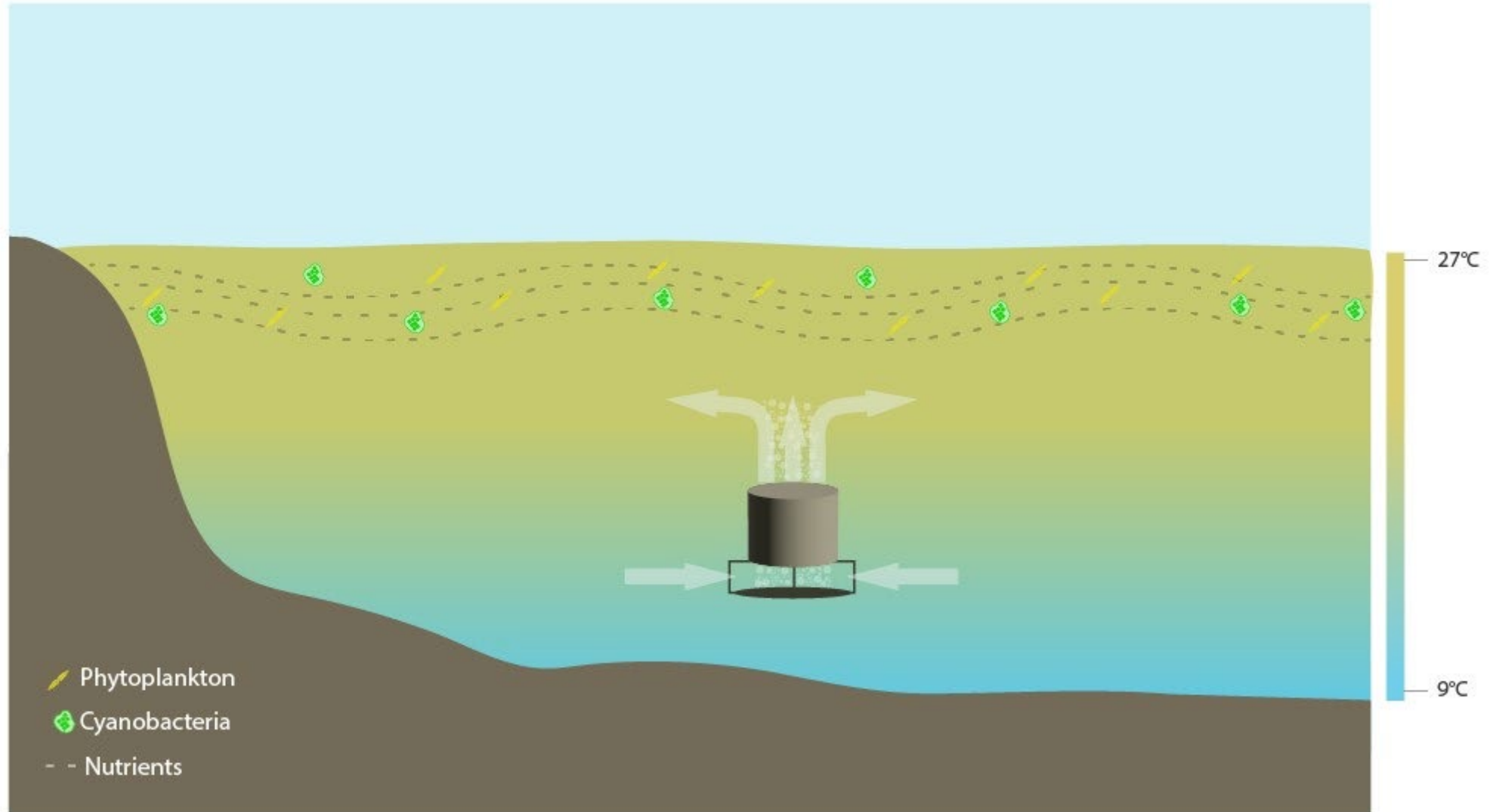- Ongoing work
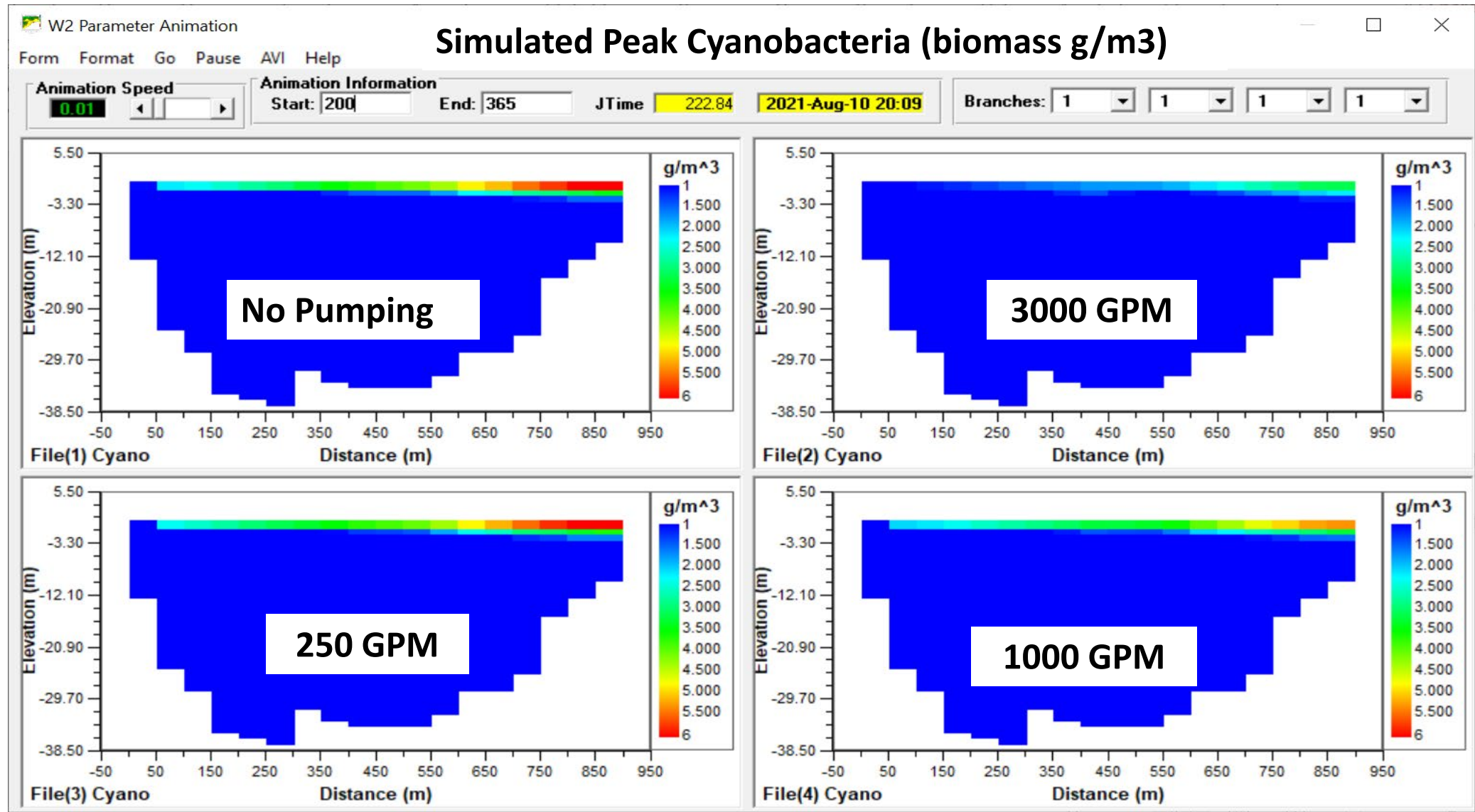 - Advancing design details and cost engineering
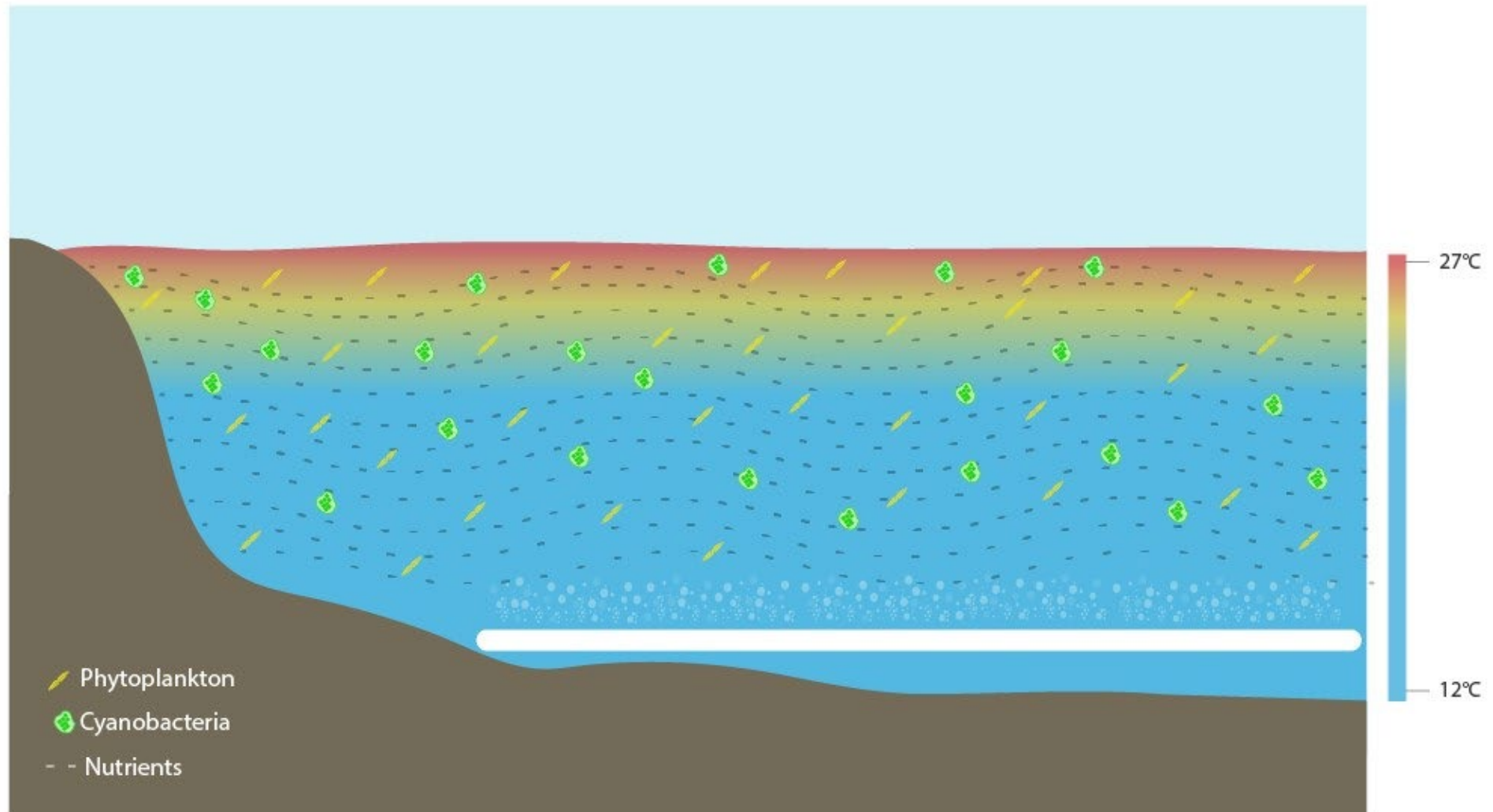
What other options did we explore? A lot!

Images: Kurt Carpenter

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Oregon State University

Alternative: Pump cold water to the surface

27°C

9°C

Phytoplankton
Cyanobacteria
Nutrients

Does it work? Yes, but energy demands are high.

Simulated Peak Cyanobacteria (biomass g/m3)

Alternative: Bubble curtain to mix the lagoon

Does it work?

Yes - Removes competitive advantage of cyanobacteria (vertical migration) and creates light limitation.

But... less effective along shallow lagoon margins.

Source: Kaeser Compressors 2022

Adds oxygen and prevents stratification

Source: Vertex 2020